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EXAMINER	
ODOM, CURTIS B	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/716,085	Applicant(s) ARSLAN ET AL.	
	Examiner Curtis B. Odom	Art Unit 2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE ____ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 March 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed 3/29/2007 have been fully considered but they are not persuasive. Applicant states (see page 8 of the Remarks) "the invention of Ariyavisitakual (U. S. Patent No. 5, 946, 351) is only applicable to an SISO channel. The feedforward filter in Ariyavisitakual is based on minimizing MSE (see column 4, line 48), not maximizing SNR. The reference to maximizing SNR in Ariyavisitakual (column 3, line 61 to column 4, line 15, equation 2) is only for the purposes of timing estimation or tap selection, not for filter design. Further, the filter in the first embodiment of Liang (U. S. Patent No. 6, 314, 147) is designed to minimize MSE without affecting the inter-symbol interference (ISI). The filter in the second embodiment of Liang is designed to maximize SNR (or SINR) based on the energy in the filtered signal to the energy in the filtered noise (equation 15).

In contrast, the independent claims of the present application disclose a method and several apparatus that maximize SNR based on a ratio of the energy in a first subset of output channel taps to energy in a second subset of output channel taps. Thus, by definition, the filter in the independent claims of the present invention affects ISI, which does not occur in the first embodiment of Liang. Also, SNR in the independent claims of the present invention does not have the same meaning as in the second embodiment of Liang."

However, Ariyavisitakual discloses a MMSE-DFE for filtering a received signal using initial channel taps of a feedforward filter (see column 4, lines 16-25) filter precursor ISI to

generate output channel taps to filter postcursor ISI (see column 1, lines 21-30). Liang et al. further shows (see Fig. 2, block 140, and column 7, lines 21-40) the MMSE filter filters each received stream of the MIMO system individually. Thus, it is the understanding of the Examiner that MMSE-DFE filters could be implemented to filter each individual data stream in the MIMO system, thus making the invention of Ariyavisitakaul applicable to an MIMO channel.

As shown above, the Applicant states "the feedforward filter in Ariyavisitakual is based on minimizing MSE (see column 4, line 48), not maximizing SNR. The reference to maximizing SNR in Ariyavisitakual (column 3, line 61 to column 4, line 15, equation 2) is only for the purposes of timing estimation or tap selection, not for filter design." However, Ariyavisitakual maximizing SNR by tap selection in the filter (see column 3, line 61-column 4, line 15 and column 7, line 62-column 8, line 45). It is also the understanding of the Examiner that tap selection is in fact apart of filter design.

The Applicant further states "the filter in the independent claims of the present invention affects ISI, which does not occur in the first embodiment of Liang. Also, SNR in the independent claims of the present invention does not have the same meaning as in the second embodiment of Liang." However, in the first embodiment of Liang et al., Liang et al. discloses that the conventional MMSE filter can simultaneously suppress ISI and CCI (see column 9, lines 26-28). Thus it is the understanding of the Examiner that the first embodiment of Liang et al. discloses affecting ISI. Furthermore, the Applicant has not disclosed how the SNR in the independent claims is different from the second embodiment of Liang et al, thus it is the understanding of the Examiner that SNR of the claims and that disclosed by Liang et al. have the same meaning.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liang et al. previously cited in Office Action 12/29/2006) in view of Ariyavisitakual (previously cited in Office Action 12/29/2006), hereinafter referred to as Reference B.

Regarding claim 1, Liang et al. discloses a method of receiving (see Fig. 2, block 100) a signal from a multiple-input-multiple-output (MIMO) communication channel (see column 3, lines 44-51), the method comprising:

generating initial channel coefficients (taps) (see Fig. 2, blocks 150 and 180, see column 8, lines 1-17) based on a channel vector (see column 8, lines 1-17) representing an impulse response estimate (see column 2, lines 50-56) of the MIMO communication channel; and

pre-filtering (see Fig. 2, block 140) the received signal using the initial channel coefficients (see column 8, lines 1-17) to generate a corresponding output signal having increased signal-to-noise ratio (SNR)and uncorrelated ISI (see column 9, lines 32-36, wherein canceling ISI and CCI increases SNR), and wherein an SNR value (see column 11, line 67-column 12, line 5, see Equation 15) is based on a ratio of energy. Liang et al. does not specifically disclose pre-filtering the received signal using the initial channel taps to generate

output channel taps and wherein the SNR is based on a ratio of energy in a first subset of the output channel taps to energy in a second subset of the output channel taps.

However, Reference B discloses filtering a received signal using initial channel taps of a feedforward filter (see column 4, lines 16-25) filter precursor ISI to generate output channel taps to filter postcursor ISI (see column 1, lines 21-30) and a corresponding output signal having maximized signal-to-noise ratio (SNR), (see column 3, line 61-column 4, line 15) and uncorrelated noise (see column 6, lines 18-27, wherein both correlated and uncorrelated noise are canceled), and wherein the SNR (see column 5, lines 5-35, see Equation 3) is based on a ratio of power in a first (numerator) subset (maincursor) of the output channel taps to power in a second (denominator) subset (precursor) of the output channel taps.

Therefore, it would have been obvious to one skilled in the art at the time the invention was made to modify the MMSE filter of Liang et al. with the MMSE-DFE of Reference B since Reference B states this DFE can optimize digital receiver performance in multipath channel environments (see column 1, lines 41-46).

Regarding claim 2, Liang et al. further discloses pre-filtering the received signal to maximize the SNR of the output signal (see column 11, lines 34-37).

Regarding claim 3, Reference B further discloses output channel taps in the feedback filter comprise all output channel taps except for the output channel taps in the feedforward filter (see column 1, lines 16-30). It would have been obvious to include this feature since Reference B states this DFE can optimize digital receiver performance in multipath channel environments (see column 1, lines 41-46).

Regarding claim 4, Reference B discloses the output channel taps in the feedback filter comprise all the output channel taps except for the output channel taps in the feedforward filter (see column 1, lines 16-30 and except for a predetermined number of the output channel taps which have not been selected by the feedforward filter (see column 4, lines 26-32). It would have been obvious to one skilled in the art to include this feature since Reference B states reducing the number of feedforward filter taps optimizes digital receiver performance in multipath channel environments (see column 1, lines 41-46).

Regarding claim 5, Reference B discloses the output channel taps in the feedback filter comprise all the output channel taps except for the output channel taps in the feedforward filter (see column 1, lines 16-30 and except for a predetermined number of the output channel taps which that follow the taps of the feedforward filter which have not been selected by the feedforward filter (see column 4, lines 26-32). It would have been obvious to one skilled in the art to include this feature since Reference B states reducing the number of feedforward filter taps optimizes digital receiver performance in multipath channel environments (see column 1, lines 41-46).

Regarding claims 6-8, Reference B discloses scaling the taps of the feedforward filter to F-1 tap delay times (see column 6, lines 13-17). The taps have different scaled values of 0, D, and 2D (see column 7, lines 38-55). Therefore, it would have been obvious to one skilled in the art at the time the invention was made to scale the taps of the first and second subset of taps differently since Reference B states a non-contiguous tap scaling (0, D, 2D) performs significantly better than a contiguous tap assignment (see column 1, lines 38-40).

Regarding claim 9, Reference B discloses wherein the SNR (see column 5, lines 5-35, Equation 3) is based on a ratio of main-cursor power (numerator) in the first subset of the output channel taps to the sum of noise power and precursor power in the second subset (denominator) of the output channel taps.

Regarding claim 10, the claimed apparatus discloses features corresponding to the above rejection of claim 1, which is applicable hereto.

Regarding claim 11, the claimed apparatus discloses features corresponding to the above rejection of claim 2, which is applicable hereto.

Regarding claim 12, the claimed apparatus discloses features corresponding to the above rejection of claim 3, which is applicable hereto.

Regarding claim 13, the claimed apparatus discloses features corresponding to the above rejection of claim 4, which is applicable hereto.

Regarding claim 14, the claimed apparatus discloses features corresponding to the above rejection of claim 5, which is applicable hereto.

Regarding claim 15, the claimed apparatus discloses features corresponding to the above rejection of claim 6, which is applicable hereto.

Regarding claim 16, the claimed apparatus discloses features corresponding to the above rejection of claim 7, which is applicable hereto.

Regarding claim 17, the claimed apparatus discloses features corresponding to the above rejection of claim 8, which is applicable hereto.

Regarding claim 18, the claimed apparatus discloses features corresponding to the above rejection of claim 9, which is applicable hereto.

Regarding claim 19, Liang et al. discloses a wireless terminal (Fig. 1, block 20) comprising:

an antenna (Fig. 1, element 80, see column 3, lines 44-47) that is configured to receive signals from a multiple-input-multiple-output (MIMO) communication channel;

an analog front end (AFE) circuit (Fig. 1, block 90, see column 1, lines 5-55) that is configured to down-convert a received signal from the MIMO communication channel to a representation of the received (baseband) signal;

a channel estimator for generating initial channel coefficients (taps) (see Fig. 2, blocks 150 and 180, see column 8, lines 1-17) based on a channel vector (see column 8, lines 1-17) representing an impulse response estimate (see column 2, lines 50-56) of the MIMO communication channel; and

a filter for pre-filtering (see Fig. 2, block 140) the received signal using the initial channel coefficients (see column 8, lines 1-17) to generate a corresponding output signal having increased signal-to-noise ratio (SNR) and uncorrelated ISI (see column 9, lines 32-36, wherein canceling CCI and ISI increases SNR), and wherein the SNR (see column 11, line 67-column 12, line 5, see Equation 15) is based on a ratio of energy. Liang et al. does not specifically disclose pre-filtering the received signal using the initial channel taps to generate output channel taps and wherein the SNR is based on a ratio of energy in a first subset of the output channel taps to energy in a second subset of the output channel taps; and

an equalizer (Fig. 2, block 190) that is configured to equalize the output signal to provide an estimate (see column 4, lines 5-11) of desired symbols in the received signal.

Liang et al. does not specifically disclose pre-filtering the received signal using the initial channel taps to generate output channel taps and wherein the SNR is based on a ratio of energy in a first subset of the output channel taps to energy in a second subset of the output channel taps.

However, Reference B discloses filtering a received signal using initial channel taps of a feedforward filter (see column 4, lines 16-25) filter precursor ISI to generate output channel taps to filter postcursor ISI (see column 1, lines 21-30) and a corresponding output signal having maximized signal-to-noise ratio (SNR), (see column 3, line 61-column 4, line 15) and uncorrelated noise (see column 6, lines 18-27, wherein both correlated and uncorrelated noise are canceled), and wherein the SNR (see column 5, lines 5-35, see Equation 3) is based on a ratio of power in a first (numerator) subset (maincursor) of the output channel taps to power in a second (denominator) subset (precursor) of the output channel taps. Therefore, it would have been obvious to one skilled in the art at the time the invention was made to modify the MMSE filter of Liang et al. with the MMSE-DFE of Reference B since Reference B states this DFE can optimize digital receiver performance in multipath channel environments (see column 1, lines 41-46).

Regarding claim 20, the claimed apparatus includes features corresponding to the above rejection of claim 19, which is applicable hereto.

Regarding claim 21, Liang et al. and Reference B disclose the method of claim 1 (see rejection of claim 1) can be included in a wireless communication system including a base station (see Liang et al, Fig. 1, block 10) and a wireless terminal (see Liang et al., Fig. 1, block 20).

Regarding claim 22, Liang et al. and Reference B further disclose the method of claim 1 can written as software for DSP and for microprocessors (see Liang et al., column 17, lines 26-30).

Conclusion

4. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Curtis B. Odom whose telephone number is 571-272-3046. The examiner can normally be reached on Monday- Friday, 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jay Patel can be reached on 571-272-2988. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Curtis Odom
June 10, 2007